3.14 HERBICIDES

Herbicides are widely used in industrial forestry to enhance reforestation and conifer growth by reducing competition for space, light, and water from grasses, forbs, brush, and hardwoods. Any intensive forestry management relying on clear cut harvest would use herbicides. Herbicides used in the Project Area may potentially affect human health and the environment, including plants, fish, wildlife, and stream and drinking water quality, in and around the Project Area.

PALCO is seeking incidental take authorization for effects to covered species that may result from use of herbicides. Because herbicide use is a component of the SYP and because long-term sustained yield depends on it, this section describes the types and uses of herbicides, the environments affected, and the potential effects on these environments. Herbicide use is part of the forestry practices planned under the SYP. Herbicide use on the PALCO ownership is subject to a separate regulatory process and could continue even with the No Action alternative.

3.14.1 Affected Environment

3.14.1.1 Potential for Environmental Exposure

Because the application occurs on private timberland, the potential for public exposure is limited. Nearby residents and other members of the public such as forest visitors and recreational users may be exposed through accidental overspray or herbicide drift, particularly from aerial application or where foliar spray application immediately adjoins public use or residential land. Where herbicide runs off or enters the groundwater, it has the potential to contaminate public water supplies and affect populations remote from the site of application. Groundwater contamination from pesticides has been a problem in many agricultural areas. Finally, for persistent or bioaccumulative herbicides, the public could be exposed to residual contamination in the flesh of grazing animals or fish exposed to contamination.

The environment affected by herbicide applications is the wet coastal forests of northwest California. This area is characterized by diverse plant and wildlife species and a wide variety of habitat types. Plants, wildlife, and habitat types found on PALCO and Elk River Timber Company lands in the Project Area are similar. Approximately 250 species of wildlife are known to occur or may occur near PALCO and Elk River Timber Company lands in the Project Area (Section 3.10). These species include a rich diversity of invertebrates, amphibians, reptiles, birds, and mammals associated with the wide variety of habitat types.

The Project Area encompasses a number of different watersheds with associated streams, creeks, and rivers. In addition, wetlands and riparian lands are also found throughout the Project Area. A large diversity of fish and invertebrates associated with these aquatic habitats occurs within the Project Area. These species include salmonid and non-salmonid fish, arthropods, and mollusks. More-detailed discussions on the affected environment are presented in other sections of the document.

3.14.1.2 Herbicide Use in Forestry

Herbicides are used on timberlands to control competing and undesirable plant species and to allow commercially valuable species the opportunity to maximize growth. The forester seeks two types of herbicidal activity. Pre-emergent herbicides inhibit seed germination or reduce seedling survival. They are used to prevent weed species from becoming established and are applied to sink into the soil and remain active in the shallow root zone. Postemergent herbicides kill established plants through translocation, so that a sufficient dose applied to a part of the plant will kill the entire plant. Thus postemergents are applied to the foliage, to the basal stem, to frill cuts on the stem of larger hardwood ("hack and squirt"), or to the stump of cut vegetation to kill the root and prevent sprouting. Aerial herbicide application is sometimes used where broadcast treatment is required to control competition from brush and undesirable species over large areas.

For routine vegetation control after clear cut, it is common for both a soil active preemergent herbicide and a foliar postemergent herbicide to be mixed and applied at the same time. The postemergent kills established weeds, and the preemergent has residual activity throughout the rest of the growing season. For clear cuts, this treatment will be done once in the first year and once again one to three years later. When working where conifer sprouts or seedlings are present, the application is done by hand—an individual with a backpack sprayer targets weeds and avoids young trees.

Where brush and non-commercial hardwoods such as tan oak and madrone have become established, reconversion to conifer requires a different technique. Small brush can have a postemergent herbicide applied to the basal bark; larger trees are frilled or cut and stump treated.

3.14.1.3 Herbicides Used

The herbicides available for use in forestry in Humboldt County are described below.

GLYPHOSATE

Glyphosate is a phosphono amino acid with broad-spectrum postemergent activity on grasses and broadleaf plants. Formulations include Roundup™, Accord™, and Rodeo™. Glyphosate is almost always applied to foliage, but it can also be used in a frill or stump treatment. It has no soil activity. Because glyphosate is readily water soluble and only slowly penetrates plant material, it can be washed off by rainfall shortly after application. Adjuvants are needed to speed penetration; the formulation of Roundup includes a surfactant which accounts for much of the product's aquatic toxicity. Rodeo, without the surfactant, is labeled for use on aquatic vegetation on open water.

TRICLOPYR

Triclopyr has activity as a synthetic auxin, a mimic of a naturally occurring plant hormone, and is used to control perennial broadleaf weeds and brush. Depending on the form of the active ingredient, triclopyr is formulated as Garlon 3A® (acid salt) or Garlon 4® (ester) and may be applied to foliage, to basal bark, or as a frill treatment.

2,4-D

2,4-D is a systemic herbicide with auxin-like activity used to control many types of broadleaf vegetation. It is widely used in the United States for the control of woody species such as willow, alder, sumac, and sagebrush. Many different formulations, including esters, amines, and salts of the primary acid , are prepared for use in the field and sold by several manufacturers. Variations in these formulations affect toxicity, mobility, volatility, and persistence to some degree.

ATRAZINE

Atrazine is one of the most commonly used herbicides in the United States as a selective postemergent herbicide primarily in corn and nonselectively on industrial sites. Atrazine is applied to the soil or to run off onto the soil. Used under the formulation name Aatrex, in forestry it has the effect of a short-duration preemergent herbicide and is tank mixed with Garlon or Roundup.

SULFOMETURON METHYL

Formulated as Oust®, sulfometuron methyl is used on noncrop areas for nonselective weed control as a broad spectrum pre- and postemergent herbicide. It is applied to the soil at extremely low rates and has moderate to long persistence. Sulfonylureas are potent herbicides; thus, they are used at much lower rates than other herbicides. PALCO forest management application rates of Oust® are 0.17 pounds per acre. As with atrazine, in forestry Oust has the effect of a preemergent herbicide and is tank-mixed with a more active postemergent such as Garlon or Roundup.

HEXAZINONE

Hexazinone is a systemic herbicide that works by inhibiting photosynthesis in target plants (Kamrin 1997). Rainfall or irrigation is necessary for activation. A relatively new forestry herbicide, Hexazinone is used to release of conifers from competing vegetation and nonselectively for the control of weeds and woody plants (Norris et al., 1991). Because it can be applied directly in granular form, it is more economical than some alternatives. The most commonly used forest management formulation is Velpar. Velpar may be used as either a pre- or postemergent foliar spray during active plant growth. Because redwood is particularly sensitive to hexazinone, it is not usually used in the coastal part of Humboldt County (Paul Holzberger, Humboldt County agriculture Department, Personal communication, September 18, 1998).

IMAZAPYR

Imazapyr can be applied to establish and maintain wildlife openings, to prepare sites for reforestation, and to release conifers from competing vegetation (Ahrens, 1994). It also provides control of many annual and perennial weeds including grasses, broadleafs, vines, brambles, brush, and trees (Ahrens, 1994). Two forms of the compound are often used in forest management, Arsenal and Chopper. Arsenal is most commonly used for industrial and right-of-way use and other forest management practices. Chopper is used for cut stump, basal bark, and frilling use. Additional research is being conducted to support the use of the granular product for conifer site preparation and reforestation (Ahrens, 1994).

Imazapyr's mode of action inhibits acetolactate synthase. Plant death results from disruption of biosynthesis of branch chained amino acids (Kamrin, 1997). The compound may be used as either a pre- or postemergent. Postemergent use is preferred for the control of perennial species. For maximum herbicidal activity, weeds should be growing at the time of application. Depending on the species, the rate of application ranges from 2 to 6 pints/acre. Arsenal is mixed with water; Chopper is mixed with diesel fuel or water.

ADJUVANTS

Applicators may add adjuvants to the formulation as supplied by the manufacturer. Generically these additives help keep the herbicide on the target, improve wetting and tissue penetration. They range from conventional surfactants to petroleum products, glycols, and alcohols, to the more recent silicone oils such as R-11. The adjuvants are also subject to registration and label restrictions.

DILUENTS

As supplied by the manufacturer, the herbicide's active ingredient is in a concentrated form and is usually diluted for application. The exception is some frill treatments where undiluted herbicide is applied directly to the cut surface of the stump. The most common diluent is water, which serves for both water-soluble and poorly soluble herbicides. Poorly soluble herbicides are dispersed in water with a surfactant usually provided in the commercial stock solution. For basal bark treatment, the oil-soluble herbicides such as trichopyr or 2,4-D will be mixed with diesel oil or vegetable oil which helps the herbicide adhere to and penetrate the bark.

3.14.1.4 Regulation

Herbicide uses are regulated by the EPA and by the California Department of Pesticide Regulation (CDPR). Under state and federal law, only certain herbicides are approved for forestry use. They must be applied as specified on the label. The application requires a written recommendation of a pest control advisor (PCA) and must be done under the supervision of state-certified applicators. Herbicide use is inspected by and reported to the county agricultural commissioner.

One important key to all pesticide regulation is the product label. This strictly limits the application rate, method, site, and target species. The label is approved by the EPA and the state and is revised frequently to add, modify, or delete applications. The label applies to a specific formulation, sold by an individual manufacturer. Different formulations with the same active ingredient may have different labels due to different chemical forms of the herbicide used, to different additives such as surfactants, or to different marketing and registration history. Toxicity and environmental fate information is collected on the active ingredient, but it is the specific formulation that is regulated at the application level. The technical analysis supporting the pesticide registration process is set forth in the EPA Registration Standards and Re-Registration Eligibility Decision.

Worker exposure to herbicides is controlled through the registration and labeling process. The label specifies what protective clothing and other equipment is necessary. The certification, training, and field supervision requirements of state and federal law are directed to worker and environmental safety.

3.14.1.5 Water Quality Protection

The NCRWQCB basin plan addresses herbicide use and protection of water quality and beneficial uses (refer to Section 3.4). Potential for the herbicide to enter the stream depends on the mode of application. The NCRWQCB has monitored aerial application of herbicides because of the significant potential for direct entry into watercourses. In several instances detectable levels of herbicides were measured. In the vast majority of cases, however, herbicides did not reach the stream in measurable concentrations.

The state and the nine regional RWQCBs have entered into a management agreement with CDPR such that CDPR serves as the lead agency for pesticide regulation and will take into account water quality information provided by the regional boards. If a water quality problem arises, the agreement defines the process for RWQCBs to go through CDPR to provide additional protection. The regional boards could also amend the basin plan and require monitoring. Under the Porter-Cologne act, the board can require report of waste discharge.

The NCRWQCB has determined that ground application as practiced on PALCO land poses little threat to water quality because of its lower application rate and lower likelihood of inadvertent stream contamination. The Board has conducted some water quality monitoring on PALCO land. One series of sampling was in conjunction with atrazine application near the Hydesville Community Water District water supply which tested no detect for atrazine and Garlon. A second series of tests was at three private wells in the Yager Creek drainage which tested no detect for atrazine, Garlon, and Oust (Personal communication, C. Wright-Shacklett, NCRWQCB; Personal communication September 21, 1998). In other tests, conducted on Owl Creek, RWQCB staff took stormwater samples near an Aatrex application and the herbicide test was no detect (Personal communication, E. Dudeck RWQCB, September 18, 1998

Based on this and similar experience, the NCRWQCB has granted forestry waivers for report of waste discharge for ground application. The waivers could be canceled if the board were to determine that any discharge of herbicides was occurring which impacted beneficial use of water. This is the same process the board has done for sediment from road construction.

NCRWQB suggested BMPs to protect water quality from ground applications (June 12, 1998). At this point in time the board is trying to establish a voluntary relationship with timber companies to collect information showing the effectiveness of the boards BMP. The list is as follows:

1. No herbicide application within a watercourse lake protection zone. (Under FPR, these zones range from 50 to 150 feet depending on slope gradient.)

2. An untreated 25-foot buffer should be maintained on all Class III (ephemeral) watercourses.

3. No foliar treatment when wind speeds exceed 10 mph.

4. Discontinue applications if there is a greater than 50 percent chance of rain within a 24-hour period.

5. A copy of the company's spill contingency plan should be kept on-site in case of an accidental spill of hazardous materials.

6. Prior notification of any application of chemicals to adjacent landowners within 300 feet of the spray area, landowners immediately downstream (within 1,000 feet) of the treatment area, and downstream local public water purveyors. Special precautions should be implemented when a domestic water source is identified downstream of the treatment area.

7. Unit marking or identification should be provided to assure the contractor will confine the spray material to the prescribed treatment area.

8. Routine inspections by company personnel should be conducted in addition to any county agricultural inspections.

9. The company may wish to conduct periodic water quality monitoring to verify that BMPs are working to protect water quality. Water monitoring samples should use a state certified laboratory.

3.14.1.6 Current Herbicide Use

Humboldt County has five major timber companies, with PALCO currently producing nearly half of the county timber volume annually. The county agriculture department recently tabulated herbicide use in forestry based on required use reporting. Table 3.14-1 lists the data for 1997.

In 1997, PALCO herbicide use accounted for much of the county activity as PALCO continued its program of reforestation. In prior years, other timber companies, notably Barnum and Simpson, have done the same (Personal communication, P. Holzberger, Humboldt County Agriculture Department, September 18, 1998). The usage in 1997 is typical of the past five years. It illustrates a trend away from use of 2,4-D which is only the material of choice for a few hard-to-kill weeds such as manzanita. Similarly, usage of atrazine is declining due to concerns over groundwater contamination outside of Humboldt County. Oust, its replacement, has not developed that history and is used increasingly in sensitive areas even though it is more expensive and not as broad spectrum as atrazine. Hexazinone is used in the eastern portion of the county and very little in the redwood forest (Paul Holzberger, op. cit.). Diesel or other oils used as diluents are not reported to the county and are not included in the summary.

3.14.1.7 PALCO Herbicide Use

PALCO began large-scale use of herbicides in 1994 as part of a shift toward intensive forest management. PALCO currently uses only EPA "unrestricted herbicides" Oust®, Atrazine, Roundup®, Accord®, Garlon 3A, and Garlon 4® (PALCO, 1998). PALCO's use of herbicides is subject to all applicable federal and state laws. PALCO does not use aerial application of herbicides and has not applied for incidental take coverage for aerial application (PALCO, 1998). PALCO herbicide applications in 1997 are listed in Table 3.14-2 and the use of specific formulations is summarized in Table 3.14-3.

PALCO is engaged in a multi-year reforestation program, reclaiming hardwood areas from older unmanaged clear cut harvests. The current rate of reforestation is 2,000 acres per year and is expected to continue at that rate for another ten years (Personal communication, Mark Rodgers, PALCO). The reforestation area plus ongoing clear cut harvest amounted to some 4,850 acres in 1997. Similar activity is underway in 1998, with the substitution of Oust for most of the Aatrex application. While slightly more expensive, PALCO is seeking to reduce the potential for groundwater contamination from atrazine. By comparison, in 1997, PALCO used 2,587 gallons of Aatrex on 2,847 acres which would have an equivalent treatment with 7,041 ounces of Oust (approximately 55 gallons) (Mark Rodgers, op. cit.).

Herbicide application on PALCO land is entirely conducted by contractors, and not by company employees. Applications are subject to PALCO's PCA recommendations and are overseen by PALCO staff. The treatment contracts include maps, and strict requirements for safe application. PALCO has been following the NCRWQCB BMPs to protect water quality from ground applications (listed above) (Personal communication, Dan Opalach, PALCO, September 18, 1998) This includes setbacks from watercourses. Detection limits in the laboratory tests were several hundred times lower than the levels used as drinking water standards and 1,000 times lower than the levels found in laboratories to affect aquatic animals. Laboratory tests conducted for PALCO by North Coast Laboratories, Ltd., Arcata, in 1998, reported limits of detection for glyphosate at 5.0 µg/L (5 ppb), Garlon 0.10 µg/L (0.1 ppb), and atrazine 0.50 µg/L (0.5 ppb).

PALCO has conducted water sampling in conjunction with the NCRWQCB and on its own. In approximately 50 applications in 1997 and the spring of 1998, stream base flow, or stormwater flow has been sampled and tested as appropriate for atrazine, triclopyr, Oust, and glyphosate. All samples were tested as no detection. It is PALCO's intent to integrate past testing

Table 3.14-1. Forest Herbicide Applications for Humboldt County in 1997

Product	EPA#	Active Ingredient	Applications in 1997 Number	Applications in 1997 Quantity	Applications in 1997 Acres
Herbicides					
Aatrex 4L	100-497	atrazine 41%	163	3,612 gal.	4,435
Garlon 4	62719-40	triclopyr 62%	122	2,868 gal.	6,067
Garlon 3A	62719-37	triclopyr 44%	20	288 gal.	722
Accord	524-326	glyphosate 42%	61	304 gal.	1,738
Roundup	524-445	glyphosate 41%	9	58 gal.	242
Oust	352-401	sulfometuron-methyl 75%	25	2,379 oz.	849
Esteron99	62719-9-264	2, 4-D 66%	28	467 gal.	1,369
LV 4	264-529	2, 4-D 63%	5	87 gal.	253
Al 2,4-D	42750-22	2, 4-D 62%	3	4 gal.	45
Pronone	33560-21	hexazinone 10%	1	500 lbs.	30
Spreader/Adjuvants					
Moract	2935-50098	petroleum oil 83%, fatty acid esters 15%	23	55 gal.	523
R-11	2935-50142	ethanols, silicone 90%	41	142 gal.	1,691
Activator90	36208-50014	polyoxyethylene ether and fatty acids 85%, isopropanol 5%	22	197 gal.	1,199
Total Area Treated in 1997 (less than sum due to simultaneous application)					**11,096**

Source: Data from monthly usage filings from five timber companies.

Compiled by Paul Holzberger, Humboldt County Agriculture Department, 1998.

Table 3.14-2. PALCO Herbicide Applications 1997

Purpose	Herbicide Mix	Area Treated (acres)	Rate (gal/acre)	Quantity (gallons)
Post Clear-Cut				
Pre/Postemergent	Aatrex 5%	227	0.75	170
	Garlon 1%		0.15	34
Pre/Postemergent	Aatrex 5%	307	0.99	304
	Roundup 1%		0.20	61
	R-11 0.25%		0.05	15
Pre/Postemergent	Aatrex 5%	231	1.00	231
	Accord 2%		0.20	46
Pre-emergent	Aatrex 5%	1,882	1.00	1,882
Forest Rehabilitation				
Frill	Garlon 3A 2%	559	0.52	281
Foliar Treatment	Garlon 4 2%	342	0.57	195
	R-11 0.05%		0.14	48
Basal Bark	Garlon 4 2%	1,305	0.84	1,096
	Diesel	0	40[1/]	50,000[1/]
	Total all treatments	**4,853**		

Source: PALCO 1998, Unpublished data

1/ Estimates by TRA, based on information from Northwest Forest and Marine, Inc. (Personal Communication, T. Perrett, Field Supervisor, January 7, 1999).

Table 3.14-3. PALCO Herbicide Material Usage Summary 1997

Material/Function	Product	Quantity (gallons)	Area (acres)
Glyphosate	Roundup	104	538
Postemergent	Accord		
Triclopyr	Garlon 3A	1,616	2,433
Postemergent	Garlon 4		
Atrazine	Aatrex	2,587	2,647
Pre-emergent			
Adjuvant	R-11	63	649

Source: PALCO 1998, Unpublished data

into a program with the Regional Board (Dan Opalach, op. cit.).

3.14.2 Thresholds of Significance

The thresholds of significance associated with the use of herbicides within the Project Area fall into four primary areas:

- Levels of use that exceed regulatory standards, including those set by the California Department of Pesticide Regulation
- Levels of use that cause an adverse effect on human health and drinking water quality
- Levels of use that cause an adverse effect on terrestrial wildlife species, aquatic organisms, water quality, and

terrestrial or aquatic non-target plant species

- Levels of use with long-term persistence and/or bioaccumulation effects

The only quantitative thresholds of significance are associated with established regulatory standards. Applicable regulatory standards are as follows:

- Federal Clean Water Act—The Clean Water Act, as amended, Title 40 CFR Parts 112, 122, and 125 strives to protect waters of the U.S. by restoring and maintaining the chemical, physical and biological properties of these waters. Numerical standards for drinking water have been established only for glyphosate (Roundup® and Accord®), and atrazine. Numerical standards for the protection of terrestrial and aquatic species have not been established for any of the herbicides used by PALCO.
- Porter-Cologne Water Quality Control Act of 1972 – The Porter-Cologne Water Quality Control Act of 1972 established jurisdiction of the nine RWQCBs to control pollutant discharges to surface and groundwater. The North Coast RWQCB is the local enforcement agency. No numerical standards have been established for any of the herbicides used by PALCO.
- NCRWQCB Basin Plan – No numerical standards have been established for any of the herbicides used by PALCO (see Section 3.4, Watersheds, Hydrology, and Floodplains).
- Safe Drinking Water and Toxic Enforcement Act (Proposition 65) – The Safe Drinking Water and Toxic Enforcement Act (Proposition 65) prohibits the discharge of any substance known to cause birth defects or cancer into sources of drinking water. None of the herbicides used by PALCO is listed under Proposition 65.

Under Section 7 of the FESA, the EPA is required to consult with the FWS and NMFS on the registration of compounds that are likely to adversely affect listed species and their habitats. At present, the forest herbicides addressed here have not yet undergone consultation for the species proposed for coverage in the PALCO HCP, and no numerical standards have been set that incorporate protection for endangered species.

3.14.3 Environmental Effects of Alternatives

Herbicide use would be a part of any intensive forestry on PALCO land and thus would be a component of the Proposed Project and all alternatives, except for Alternative 3, selective harvest. The independent review of the LTSY model noted the contribution to long-term sustained yield from vegetation control (G. Biging, 1996, HCP/SYP, Volume III, Part F). The calculation of timber yields in the forest model used to project forest conditions over the life of the permit accounted for the growth rate increase attributable to herbicide use in conjunction with clear cut harvest methods and even age stand management. Because herbicide use is not subject to the current permitting process, herbicide use could continue under the No Project, No Action alternative unless it was determined to result in a unauthorized take of listed species.

Thus, the only difference between the alternatives in the use of herbicides is the degree to which clear cut forestry is used. Differences in the degree of herbicide use and method of application depend on the amount of area to be treated. This, in turn, is based on the total harvest acreage and whether clear cut (Alternatives 1, 2, 2a, and 4) or selective harvest (Alternative 3) silviculture methods are used. Therefore, environmental effects are expected to differ only by degree and are discussed together in this section.

Under the proposed SYP, harvest in the first decade would result in 34,720 acres of clear cut. Of this total, 80 percent, or 27,776 acres would be subject to a one- or two-year herbicide treatment program for weed and brush suppression. The need for a second year of treatment depends on the effectiveness of the first year and the amount of competition between undesirable species and conifers. PALCO estimates that as much as 50 percent of the sites could be treated a second time (D. Opalach). This would be done with hand applied preemergent or pre- and postemergent mix as is now practiced on the ownership. As described above, PALCO has embarked on a program of hardwood control and rehabilitation of conifer forest. This would continue at the rate of some 2,000 acres per year for the next 10 years for a total additional first decade treatment of 20,000 acres. Reforestation would rely on a combination of foliar, basal, frill, and stump treatment with a postemergent. Thus, each year in the first decade, some 4,700 acres would be subject to first-time treatment, and up to 1,800 acres treated in the previous year would be treated again. Total herbicide application would be in the range from 4,700 to 6,100 acres per year. Treatment would decline after that when the reforestation is complete and as the SYP shifts emphasis on clear cut.

The area treated and the types of treatment would thus be similar to and slightly less than recent historical treatment (refer to Table 3.24-2). The company would likely continue the substitution of Oust for Aatrex. PALCO has applied for incidental take coverage of all the forestry herbicides listed above, including several it does not currently use. The proposed HCP seeks incidental take coverage for the use of herbicides with the following active ingredients: glyphosate, atrazine, sulfometuron methyl, triclopyr, hexazinone, imazapyr, and 2,4-D. It is anticipated that the labeling and formulation of these active ingredients may change, but the addition of another herbicide active ingredient would require amendment of the HCP.

The active ingredients and specific formulations that have been used on PALCO land are: atrazine (Aatrex), glyphosate (Accord and Roundup), triclopyr (Garlon 3A, Garlon 4), and sulfometuron methyl (Oust). PALCO uses the registered adjuvant R-11.

With Alternative 1, the area of clear cut harvest is reduced by elimination of some old growth redwood and by likely greater stream buffers. The reforestation effort would be largely unaffected, and total first decade herbicide use would be roughly one quarter less than with the proposed project. The wider stream buffers and any resulting restrictions on Class III drainages would further reduce the potential for herbicide transport to streams. Available studies do not indicate the quantitative benefit from the increase in application setback.

With Alternative 4, the extent of clear cut harvest is reduced by exclusion of the central 63,000 acres of the Reserve. The reforestation effort would continue, but the hardwood sites in the 63,000-acre Reserve would not be treated. Overall herbicide use in the first decade would be approximately half of the level projected for the proposed project. Stream buffers on the area outside the Reserve would be treated as with the proposed project.

Under selection harvest, Alternative 3, it is presumed that clear cuts and associated herbicide use would not be used. Presumably the reforestation effort would have commercial value, but is not included in the scenario for this alternative. Thus, Alternative 3 would have essentially no herbicide use and hence no potential for adverse impact.

3.14.4 Direct and Indirect Environmental Effects

Direct effects are associated with an organism coming into contact with the herbicide. There are four requirements for a direct effect. First, there must be direct physical contact with the herbicide. Second, the herbicide must be taken up or absorbed by the organism. Third, the herbicide must then be moved to the biochemical site of action within the organism, and fourth, the herbicide must reach this site of action at a high enough quantity and for a long enough time to cause an adverse effect. Toxicology traditionally assumes a threshold exists in a dose-response relationship; i.e., there is a dose below which a toxicological response does not occur. Therefore, it is possible for an organism to be exposed to an herbicide and not be adversely affected, depending on both the dose and the duration of exposure.

The primary direct effect from herbicides is on the workers applying it. Workers potentially exposed include mixer/loaders, observers, and sprayers (USDA, 1984). Direct effects on other individuals or organisms are dependent on the method of application. These direct effects are expected to be minimal for basal stem, foliar, preemergent, direct spray, and hack and squirt application techniques. Other direct effects associated with the use of herbicides include exposures via spray drift, runoff, and accumulated concentrations of herbicides in water, vegetation, and meat (USDA, 1984). Direct effects may also be associated with exposure of visitors and wildlife who enter previously treated areas. Direct effects decrease with time after application due to degradation, or loss of herbicide by transport or dilution.

Indirect effects result from modifications of habitat as a result of herbicide use (Norris et al., 1991). Indirect effects may include the loss of food sources for wildlife if non-target plants are impacted and reductions in cover and shade. Indirect effects can be both positive and negative. Examples of negative indirect effects include reduction in stream-side shade, the subsequent increase in streamwater temperature, and a decrease in plant diversity. An example of a beneficial indirect effect is the decrease in sediment yields to streams compared to mechanical site preparations (Neary et al., 1993). Indirect effects of herbicide use in forest ecosystems have not been extensively studied, are more difficult to characterize than direct effects, and are not well understood.

Few studies have examined the impact of forest herbicide use on plant diversity and ecosystem function (Neary et al., 1993). More research is needed on the cumulative effects of forest herbicides to assess the impacts on parameters such as water quality, human health, invertebrates, amphibians, reptiles, wildlife, and biodiversity (Neary et al., 1993). Under Section 7 of the FESA, the EPA is required to consult with the FWS and NMFS on the registration of compounds that are likely to adversely affect listed species and their habitats. The forest herbicides addressed here have not yet undergone consultation, so effects on listed species have not been evaluated. The scarcity of information available on the direct and indirect effects of these compounds on covered species, and the variations in their use, makes it difficult to assess the magnitude of impact likely to occur from use. Complicating the analysis of these compounds is the use of a variety of carriers or surfactants, because toxicity varies greatly based on application rates and carrier.

3.14.4.1 Herbicide Toxicity

An herbicide, by definition, is toxic to plants. In general, the mechanism of an herbicide's toxicity involves biochemical phytoprocesses (for example, photosynthesis) that do not have counterparts in animals (Ecobichon, 1991). Therefore, the toxic activity of an herbicide should be limited to its target species; however, adverse effects to non-target plants and animals can occur. Herbicides have demonstrated low toxicity in animals, with the exception of a few chemicals such as 2,4,5-T and paraquat (Ecobichon, 1991), and none of these is used in Humboldt County.

Toxicity testing is conducted to determine potential adverse effects of herbicides on a range of organisms. Typical organisms for which toxicity tests are conducted include microorganisms, aquatic and terrestrial invertebrates, fish, birds, and mammals. Usually these tests are conducted in laboratory conditions, and results must be extrapolated to natural environmental conditions, as well as to other species, including humans. Toxicity tests fall into three primary categories: acute, subchronic, and chronic.

Acute tests are given over a short time. The most common acute toxicity test is the determination of the median lethal dose (LD_{50}), or that dose which is lethal to 50 percent of the treated group. For aquatic organisms, this term is referred to as the median lethal concentration of the herbicide in water, or LC_{50}. Subchronic studies are toxicity tests conducted over a few days to several months. Exposures are either continuous over this period, or via regularly repeated doses. Measures of toxicity are usually other than death. Chronic studies are conducted over a longer time period, even over the lifetime of the test species. Chronic studies may include detection of sublethal health effects, as well as cancer and birth defects.

Herbicide toxicities vary over a wide range. In order to compare the toxicities of different herbicides and pesticides, relative toxicity ratings are used. The ratings serve as a practical guide as to toxicity of a particular herbicide or pesticide. Relative toxicity ratings are expressed in terms such as "non-toxic," "slightly toxic," "moderately toxic," "very toxic," and "extremely toxic."

Other characteristics that influence potential exposures to herbicides, and thus their potential to adversely affect exposed species, include mobility and persistence in the environment (fate and transport). An herbicide's ability to move in the environment is based on its chemical and physical characteristics, for example, its solubility in water, its vapor pressure, and its adsorption onto soil particles. The persistence of an herbicide is based on how quickly it degrades in the environment. A number of biological, physical, and chemical processes act to degrade herbicides over time. The more quickly an herbicide is degraded, the less exposure there is to that herbicide. Additionally, some herbicides are taken up by plants and animals and accumulate in their tissues, while other herbicides do not. Chemicals that tend to bioaccumulate present a greater hazard to animals (including humans) that eat the affected plants and/or prey species.

The following presents an assessment of the fate and transport and the toxicity of the forestry herbicides listed in the HCP/SYP application and which are available for use in Humboldt County. The assessment draws from available literature and considers the mode and site of application on PALCO land to gauge potential impact from use. Based on 14 years of monitoring, the NCRWQCB has found only extremely low herbicide concentrations in water from aerial application (refer to Section 3.4). Ground-based applications pose even less risk of reaching streamwaters.

So far, the NCRWQCB has not found appreciable evidence of contamination of drinking water from the type of herbicides under consideration. Because the observed and estimated public exposure is nil or negligible, there is no basis to conduct a quantitative health risk assessment. Herbicide use itself is not subject to review in this EIS/EIR. Herbicide use on the PALCO ownership is subject to a separate regulatory process and would continue even with the No Action alternative. Because the EIS/EIR addresses the proposed issuance of an incidental take permit, the analysis here focuses on potential effects to covered species, particularly aquatic organisms.

Glyphosate

In general glyphosate is considered relatively immobile in soil (Norris et al., 1991). Glyphosate adsorbs to soils and is not expected to migrate to groundwater under normal application conditions (Feng and Thompson, 1989; EXTOXNET, 1994b). Because glyphosate is tightly bound to soil, it is not expected to be associated with rain runoff. However, it would be associated with soil in erosion runoff. Glyphosate does not tend to bioaccumulate; therefore, only a slight degree of food-chain transfer is expected (USDA, 1984). Glyphosate is non-persistent and is readily degraded in the environment, primarily via biodegradation (Feng and Thompson, 1989).

Results of stream monitoring following aerial application of glyphosate indicated maximum glyphosate levels of 162 µg/L (Feng et al., 1989) in streamwaters. This level was measured in a directly sprayed stream. Levels of glyphosate rapidly dissipated in streamwater. No measurable levels of glyphosate were found in streams with a 30-foot buffer zone (Feng et al., 1989). Glyphosate concentrations in small ponds aerially treated had maximum detected concentrations in water similar to that measured in streamwaters (100 µg/L; Goldsborough and Brown, 1993).

Glyphosate is a phosphono amino acid and does not contain chlorine. Technically an organophosphorus compound, it does not inhibit cholinesterase activity as do organophosphate insecticides (e.g., malathion, and parathion) and has low animal toxicity (EXTOXNET, 1994b). Glyphosate is relatively non-toxic, but is a mild acid and, in surfactant formulations, is an eye irritant (USDA, 1984; EXTOXNET, 1994b). Glyphosate is poorly absorbed in the gastrointestinal tract and is excreted largely unchanged in mammals (EXTOXNET, 1994b). EPA has established a reference dose (RfD) of 0.1 milligram glyphosate per kilogram body weight per day (mg/kg/day) (EPA, 1997a). The RfD is an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. A recent study to evaluate the exposure of CALTRANS herbicide mixer/loaders and applicators found that absorbed dosages of glyphosate (less than 0.001 mg/kg/day) were well below EPA's RfD (Edmiston et al., 1995). EPA does not consider glyphosate a carcinogen.

The federal and state drinking water standard for glyphosate is 700 µg/L (700 ppb). Drinking water with glyphosate levels below this concentration should not pose an adverse human health risk even with over a lifetime. Based on the stream monitoring data presented above, and under normal forest applications of glyphosate, it is unlikely that individuals would consume levels of glyphosate above the federal and state drinking water standard.

Chronic toxicity tests on laboratory animals show only slight effects. Glyphosate is only slightly toxic to wild birds and is considered practically non-toxic to fish (EXTOXNET, 1994b). Roundup® had no apparent adverse effects on reproduction, growth, or survival of deer mice one year after treatment of a forest (EPA, 1997b). Results of studies have found that the effects of glyphosate on soil microflora and microbial activity are generally below significant levels. Herbicides, in general, have not been found to have long-term harmful effects on soil microbial activity, especially at recommended rates of application (Preston and Trofymow, 1989).

Glyphosate was only moderately toxic to two species of Pacific salmon, with average 96-hour LC_{50} values for coho salmon and rainbow trout of 42 and 32 mg/L, respectively (Wan et al., 1987a). A study done on an aerial application of glyphosate on small ponds indicates that it is unlikely that levels of glyphosate in standing water bodies would pose a significant acute hazard to aquatic organisms under normal forest applications (Goldsborough and Brown, 1993). Survival of aquatic invertebrates (Daphnia magna) in a forest pond did not show any significant effects at applications up to 220 pounds per acre (EPA, 1997b). Typical forest management application rates of glyphosate are approximately one to five pounds per acre (USDA, 1984). Based on these aquatic toxicity levels, the data from Feng et al. (1989) support the conclusion of Tooby (1985) that "…it is unlikely that glyphosate will affect aquatic organisms at the concentrations found in the environment after use at the recommended rates."

Atrazine

Atrazine does not tend to bioaccumulate, therefore, only a slight degree of food-chain transfer is expected (USDA, 1984; Norris et al., 1991). Atrazine is readily degraded in the environment, primarily via hydrolysis. At normal rates of application, therefore, most atrazine is degraded (Norris et al., 1991).

Atrazine is not expected to migrate to groundwater under normal application conditions (Eisler, 1989), but atrazine has been found in groundwater and in wells in some agricultural areas. The compound is widely and heavily used on some crops, such as corn, and shallow wells or wells with cracked well head casings have caused atrazine contamination of water supplies. Monitoring of atrazine in streams in agricultural watersheds found average streamwater concentrations of 1.4 µg/L (Norris et al., 1991).

Atrazine is considered non-toxic to slightly toxic to humans and other animals (USDA, 1984; EPA, 1997b). Its main toxic effect is related to photosynthesis. It can be absorbed through the skin, ingested orally, or inhaled through the respiratory tract. Chronic and acute toxicities are associated with exposures to relatively high concentrations of atrazine. Long-term exposures to high levels can cause tremors, changes in organ weights, and damage to the liver and heart (EXTOXNET, 1993a). EPA (1997a) has established an RfD of 0.035 mg/kg/day for atrazine. The federal and state drinking water standard for atrazine is 3 µg/L. Drinking water with atrazine levels below this concentration should not pose an adverse human health risk over a lifetime.

Manufacturing workers are exposed to higher levels of the chemicals over a longer time than are applicators. Examining the health of people who work with atrazine in the manufacturing environment is, therefore, an important way to evaluate risk and relate it to potential risks in other populations. Epidemiological studies at production facilities in the U.S. and Switzerland spanning 17, 27, and 30 years have not shown any indications that atrazine production workers have experienced premature mortality or that any type of cancer was associated with atrazine exposure at these facilities

(Brusick et al., 1996). EPA does not consider atrazine a carcinogen.

Atrazine is moderately toxic to a wide range of non-target plant species (USDA, 1984), but is only slightly toxic to fish and other stream life. It is considered non-toxic to bees (EXTOXNET, 1993a). Harm to fish is associated with levels above 240 µg/L (Norris et al., 1991). Effects to aquatic invertebrates and tadpoles have been measured at concentrations as low as 20 µg/L (Eisler, 1989; Detenbeck et al., 1996). Harmful levels to birds and mammalian wildlife are associated with levels above 25 ppm in soil (Eisler, 1989). Long-term accumulation studies of crops treated with one to two pounds atrazine per acre over 15 years indicated atrazine residues of 0.012 to 0.02 ppm in soil. Typical forest management application rates of atrazine are approximately two to eight pounds per acre (USDA, 1984). Under normal application conditions, atrazine levels had negligible long-term population effects on sensitive species of soil fauna (Eisler, 1989).

An ecological risk assessment panel determined that atrazine does not pose a significant risk to the aquatic environment (Baker et al., 1996). Although some inhibition of growth in algae and small aquatic plants may occur in small streams vulnerable to agricultural runoff, these effects are likely to be transient. Modeling by the panel indicates that such ecological effects, even to vulnerable sites, may be insignificant compared to the effects of sediment, which reduces photosynthetic activity by diminishing the amount of light reaching aquatic plants (Baker et al., 1996).

Sulfometuron Methyl (Oust®)

Sulfometuron methyl does not tend to bioaccumulate; therefore, only a slight degree of food-chain transfer is expected. Sulfometuron methyl is readily degraded in the environment, primarily via biodegradation (EXTOXNET, 1994a). Sulfometuron methyl is relatively immobile and is not expected to migrate to groundwater under normal application conditions (Stone et al., 1993; EXTOXNET, 1994a). The small amounts used lower the potential for impacts to non-target species. Application of sulfometuron methyl to a small watershed with a 15-foot buffer zone resulted in streamwater concentrations lower than 7 µg/L (Neary and Michael, 1989).

Sulfometuron methyl is considered a slightly toxic compound (EXTOXNET, 1994a). Several toxic effects have been observed with chronic exposures to sulfometuron methyl. At relatively low doses (50 ppm), chronic effects include increased liver weight, reduced red blood cell counts, and increased white blood cell counts (EXTOXNET, 1994a). Sulfometuron methyl is readily absorbed in the digestive tract (EXTOXNET, 1994a). EPA has not established a drinking water advisory level for sulfometuron methyl.

Sulfometuron methyl is relatively non-toxic to birds and is considered slightly toxic to freshwater fish. It is not considered a threat to adult fish; however, the embryo hatch stage of fathead minnow has shown toxic effects at concentrations of 710 µg/L (EXTOXNET, 1994a). Sulfometuron methyl was relatively non-toxic to aquatic invertebrates (*Daphnia magna*). Because sulfometuron methyl is non-selective as an herbicide, broad use may affect both terrestrial and aquatic plants if concentrations exceed the levels discussed above. However, residual soil and water levels associated with normal application and typical runoff conditions should be lower than those for atrazine and glyphosate.

Triclopyr

Triclopyr does not tend to bioaccumulate; therefore, only a slight degree of food-chain transfer is expected (USDA, 1984). Triclopyr is readily degraded in the environment, primarily via biodegradation (EXTOXNET, 1993b). Triclopyr is not expected to migrate to groundwater under normal application conditions (Norris et al., 1991; EXTOXNET, 1993b). Typical forest management application rates of triclopyr are approximately one to nine pounds per acre (USDA, 1984). Triclopyr was not detected in streamwater following its application to small watersheds (Bush et al., 1988).

Triclopyr is considered a slightly to moderately toxic compound. Several toxic effects have been observed with chronic exposures to triclopyr. At relatively low doses (100 ppm), chronic effects include decreased liver and body weight and increased kidney weight (EXTOXNET, 1993b). EPA has not established a drinking water advisory level for triclopyr.

Triclopyr is slightly toxic to birds and is practically non-toxic to some fish and aquatic and terrestrial invertebrates (USDA, 1984; EXTOXNET, 1993b). Concentrations of 500 ppm had no apparent effects on the growth of common soil microorganisms. One study indicated that Garlon 4® is slightly toxic to salmonids of the Pacific Northwest at a concentration of 1.4 mg/L (Wan et al., 1987b). Aerial overspray applications of Garlon 4® at a rate of approximately one pound per acre led to streamwater concentrations of 0.62 mg/L. Residual levels declined to 6 μg/L within one day (Wan, 1987). Because buffer zones may not be used near small ponds, higher levels of triclopyr (and other herbicides) may be associated with these water bodies. A study by Berrill et al. (1994) detected effects in tadpoles at concentrations as low as 0.6 mg/L. Triclopyr concentrations in pond water following aerial application are likely to be similar to those presented above for streamwater. This is based on the data presented above for glyphosate in which pond water concentrations were similar to streamwater concentrations following aerial applications at similar rates.

Hexazinone

Hexazinone is low in toxicity and risk to aquatic and terrestrial organisms (Neary, 1993). Hexazinone is quite mobile and is readily leached in laboratory soil studies (Norris et al., 1991). It has moderate-to-high persistence in the soil environment; measured half-lives range from 30 to 180 days (Ahrens 1994). Photo degradation and soil microbial processes are primary actions of decomposition of the compound in the environment. Because hexazinone is highly soluble in water and degrades slowly, it has the potential to contaminate groundwater. This compound typically leaves the environment through photo decomposition, biodegradation, and dilution.

Studies conducted by Berril et al. (1994) on the effects of low concentrations of forest pesticides on amphibians concluded hexazinone to be the least toxic of commonly used forest pesticides. Hexazinone probably will not pose any direct effects on resident amphibians at concentrations likely to be used in forest management (Berril et al., 1994). Hexazinone is slightly toxic to fish and other freshwater organisms and has a low bioaccumulation factor in fish (Kamrin, 1997). LC_{50} values for rainbow trout are 320 mg/L, 370 mg/L for bluegill sunfish, and 151 mg/L in Daphnia spp. It is considered to be slightly to practically non-toxic to birds; the acute LD_{50} of hexazinone for bobwhite quail is 2258 mg/kg (CIS, 1988). The LD_{50} for rats is 1,690 mg/kg; and for the male guinea pig 860 mg/kg (Ahrens et al., 1994). Hexazinone is rapidly metabolized by animals and excreted in urine or eliminated in feces within three to six days of exposure (Norris et al., 1991 and Kamrin, 1997).

Imazapyr

Imazapyr does not leach in soil; it is strongly absorbed and does not leach downward through the soil profile. Imazapyr is primarily lost to photo degradation and microbial degradation (Neary et al., 1993). When exposed to sunlight the active ingredient degrades rapidly in distilled water, with an average half life of one to two days (Kamrin, 1997). In soil, the principal means of dissipation is microbial degradation. Imazapyr is completely soluble in water. The average half life of Imazapyr is 30 days, although field half life ranges from 25 to 142 days, depending on soil type and environmental conditions (Kamrin, 1997). The half life in shallow ponds ranges from two to three days. Efficacy persists for three months to two years, depending on the application rate (Kamrin 1997).

Imazapyr generally remains within the top 20 inches of the soil profile. In forest dissipation studies, Imazapyr did not run off into streams and no lateral movement was observed (Kamrin, 1997). It is considered to have slight to no toxic effects on fish or wildlife. It is a weak acid and is excreted rapidly before accumulation in tissues occurs. LC_{50} for rainbow trout and Bluegill sunfish is greater than 100 mg/L, LC_{50} for Daphnia magna less than 100 mg/L, LD50 for bobwhite quail greater than 2,150 mg/kg. It is considered to be a mild eye, skin, and inhalation irritant. Further research is being conducted on toxicity of the compound and its use in forest management.

2,4-D

Toxicity information presented here primarily refers to the fundamental form of 2-4-D acid, unless otherwise specified. The mode of action of 2,4-D has been studied extensively over the last 40 years; however, the specific way in which it acts is still not completely understood (Mullison, 1987). 2, 4-D is known to act as a very powerful plant auxin, rejuvenating old cells and overstimulating young cells, thereby preventing normal cell maturation and differentiation (Mullison, 1987). 2,4-D has a low persistence in soil. The half-life in soil is generally less than seven days, although depending on environmental conditions, half-life can vary up to several weeks. Under unoxygenated conditions, the average half-life is one to several weeks. Despite the short half-life in soil and in aquatic environments, the compound has been found in groundwater in at least five states and has also been detected in surface waters (Kamrin, 1997). In water, microorganisms readily degrade the parent compound.

2,4-D acid is slightly to moderately toxic to wildfowl and other birds with a recorded oral LD_{50} of 500 mg/kg, and an eight-day LC_{50} of >5,620 mg/L in bobwhite quail, 272 mg/kg in pheasants, and 668 mg/kg in quail and pigeons. However, the compound is considered highly toxic to fish and other aquatic life, depending on the form (Kamrin, 1997). The LC_{50} for the acid formulation for cutthroat trout is 1 to 100 mg/L (Kamrin, 1997) and >5 mg/L for the ester formulation in rainbow trout (Ahrens, 1994). Moderate doses of 2,4-D severely impaired honeybees' brood production; the LD_{50} for the honeybee is 0.115 mg per bee. Some research indicates that high doses of 2,4-D may cause birth defects (Kamrin, 1997). Rats fed 150 mg/kg/day on days 6 and 15 of pregnancy had offspring with increased skeletal abnormalities. 2,4-D fed to rats over two years caused an increase in malignant tumors. In humans, there is conflicting information regarding the carcinogenic effects of 2,4-D; several studies suggest there is an association between 2,4-D and cancer (Kamrin, 1997).

Although the Draft HCP proposes incidental take permit coverage for use of 2,4-D, PALCO does not currently use this herbicide. If it were to be used, the most likely application would be the ester formulation from backpack sprayers (Personal communication, Dan Opalach, PALCO, September 15, 1998).

3.14.5 Cumulative and Long-term Environmental Effects

Generally speaking, recently developed herbicides are lower in toxicity and persistence than those used in the past. In addition, monitoring of aerial herbicide applications over the last 14 years has indicated extremely minor amounts of herbicides in streamwater (NCRWQCB, 1998). Ground application of herbicides should pose even lower risk (see Section 3.4.2.2). The mitigation proposed in the Draft HCP should be effective at minimizing impacts.

Based on the discussion above, PALCO's herbicide use under Alternatives 1, 2, 2a, and 4 will not be expected to exceed regulatory levels, cause adverse effects to human health, or affect drinking water quality. The effects of herbicide use on wildlife and aquatic organisms and their long-term persistence and/or bioaccumulation effects are uncertain.

The primary herbicide threat is to water quality, via direct runoff or via a tendency to adsorb to soil particles with subsequent soil erosion. High herbicide levels in surface waters are associated with major storm events shortly after application, as well as with cultivation practices. The absence of agricultural cultivation, as is the case for forest management practices, is associated with lower surface water levels (Eisler, 1989). Other differences from agricultural uses of herbicides that limit the potential cumulative environmental effects of herbicide usage in forest management include the methods and frequency of application. Agricultural practices typically consist of broad-based spraying, including aerial application over soil and foliage on a frequent basis, as opposed to PALCO's proposed forest management practices in the Project Area, in which herbicides are directly applied or ground-based sprayed on an infrequent basis (that is, once, and then a few years later, or a single application). Intermittent application of low concentrations of herbicides for forest management uses may have few or insignificant effects on surface water and groundwater quality, as well as on terrestrial and aquatic organisms (Neary et al., 1993; Feng et al., 1989; Preston and Trofymow, 1989).

Maintenance of a buffer zone is important to protect streamwater quality. Maintenance of buffer zone integrity and water quality depends on the application method, aircraft type (if aerially applied), microclimatic conditions, plot demarcation, effective drift control agents, spray application equipment, and operator skill (Wilson and Wan, 1975). Ground-based application, as proposed by PALCO, reduces the risk of direct contamination of streams, provided proper care is taken in the transport, mixing, application, and disposal of the herbicides, especially in riparian areas. In general, buffer zones are effective in minimizing herbicide contamination of streams (Neary et al., 1993). In addition, the NCRWQCB has specific regulations regarding the maximum concentration limits of certain pesticides in waterbodies. The NCRWQCB has determined that the implementation of BMPs by private forest landowners has not violated the water quality objectives stated in the Basin Plan.

Herbicides may have adverse effects on non-target plant species, including redwoods. Therefore, another concern with the application of herbicides is the cumulative effect on non-target plant species and riparian vegetation. Herbicides may kill riparian vegetation and initiate a series of adverse effects on aquatic organisms and on the stream channel. Because of the potential effects of herbicide use on redwoods, however, it is in PALCO's best interest to use proper forest management practices. Under proper forest applications, potential adverse effects on non-target plant species should be negligible.

Typically, cumulative effects from exposure to chemicals are associated with chronic exposures at persistent low levels in the environment. Another potential cumulative effect would be exposure of an individual (human or otherwise) to several different treatment areas over time and space, or a single water body resulting from runoff from several different treatment areas. Consequently, the levels to which such an individual or waterbody would be exposed from each treatment event would be minimal, except for herbicide mixer/loaders and applicators. The erosion control measures associated with the Proposed Project/Proposed Action will reduce the level of potentially affected sediment reaching streams. As discussed in Section 3.14.3, these individuals are likely exposed to levels below those considered a chronic health risk. The species that would be most significantly exposed to herbicides would likely be those exposed to only a single application event (for example, aquatic and terrestrial invertebrates, amphibians). Thus, considering the nature and properties of each herbicide (that is, they are not persistent in the environment and do not bioaccumulate), and the manner in which it is applied (that is, they are applied infrequently using direct or ground-based application techniques, with stream buffer zones), should minimize the likelihood of cumulative environmental effects from the proposed use of herbicides within the Project Area.

Although scientific information on the environmental effects of forest herbicides is expanding, there remains a substantial degree of uncertainty regarding effects of these compounds, particularly over the long term. Given existing uncertainty, the cumulative effects of herbicide use over the length of the permit period may possibly result in significant effects. Therefore, they will not be covered under the ITP at this time. Coverage may be extended under a permit amendment at some time in the future.

3.14.6 Mitigation

The following standard controls will minimize the potential for significant effects.

- No aerial applications are proposed. If the voluntary restriction continued, it would reduce contamination by direct application onto non-target areas (for example, streams), thus reducing potential exposures to high levels of herbicides in water and off-site residents.
- Consistent with state and federal requirements, herbicide applications must be under the supervision of state certified applicators, and done in accord with a specific application recommendation and the herbicide label restrictions and applied at the lowest effective rate.
- PALCO has a spill contingency plan that delineates specific measures to be carried out in the event of an accidental spill of herbicides or any other hazardous material. This plan is detailed in PALCO (1998, Volume II, Part P).

The extensive controls required by state and federal law, and the voluntary adoption of controls by PALCO including the NCRWQCB BMPs are sufficient to mitigate the potential impact on public safety and water quality to insignificance.

Even with these controls, there remains a potential that some covered species could be affected at low exposures in or near watercourses adjoining herbicide treated areas. There is information on only some of the requested herbicides on PALCO property. At present, surface water quality monitoring shows no detectable concentration of herbicide in runoff, but there is little information on herbicide levels in the actual habitat areas for some covered species and the surface water in small drainages. Because of this uncertainty, there remains some potential adverse impact on covered species.

Because potential impacts are uncertain, the impact of herbicide use on covered species is not considered to be mitigated to insignificance.